SPAWAR
Systems Center
San Diego

ONR Collaboration and Knowledge Management Program

Cognitive Elements Of Effective Collaboration

Workshop

15 - 17 Jan, 2002

Program Overview and Workshop Objectives

Mike Letsky

SPAWAR
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Workshop Objective:

Define State of the Technology in

Collaboration and Knowledge Management

- **What is it?**
- **Who is doing the science?**
- **View new initiatives.**
- **What are the future issues?**

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DEFINITIONS

COLLABORATION: Joint activity for attaining a shared understanding.

The cognitive aspects of joint analysis or problem solving for the purpose of attaining shared understanding sufficient to achieve situational awareness for decision-making or creation of a product.

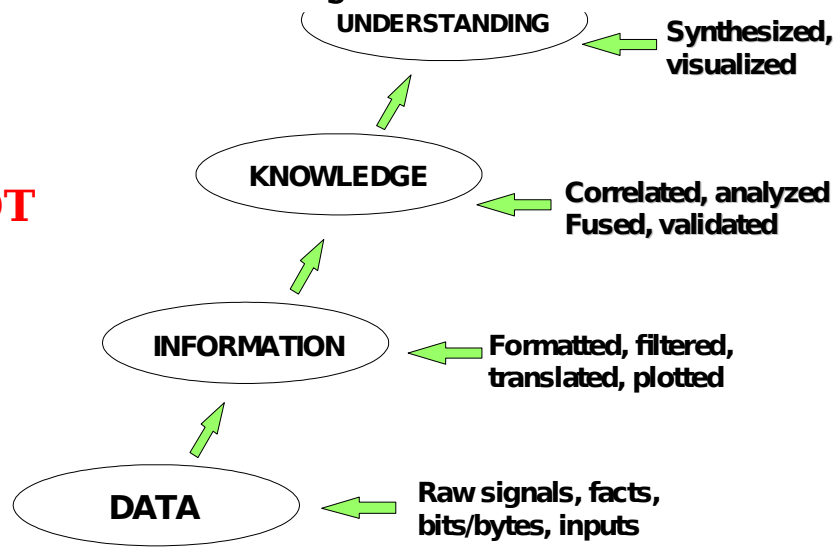
KNOWLEDGE MANAGEMENT: The identification, collection, fusion and presentation of data for the purpose of attaining comprehension of a situation.

COLLABORATION AND KNOWLEDGE MANAGEMENT

What It's Not

- **COGNITIVE FOCUS - NOT IT PERSPECTIVE**
- **PROBLEM SOLVING PROCESSES - NOT SOCIAL - BEHAVIORAL SCIENCE**
- **COA SELECTION / NDM - NOT DETERMINISTIC COGNITIVEMODELING**

Cognitive Hierarchy



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Workshop Approach:

Provide a Technical Information Exchange

To identify:

- **Gaps and Issues**
- **Exciting new work**
- **Established centers of excellence**

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ONR Program

- D&I Nature (6.1 / 6.2)
- One of three HF Thrusts at ONR
  - Decision Support / Organizational Design
  - Human Computer Interface / Visualization
  - Collaboration and Knowledge Management

Collaboration and Knowledge Management Program Objective

Develop cognitive science-based tools, models, computational methods, and human-agent interfaces to help attain common situational awareness among heterogeneous, distributed team members engaged in asynchronous, quick response collaboration for issue resolution, COA selection or decision making.

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Current Program

Thrust Area: Representation And Transfer of Meaning

- Electronic Card Wall — MIT
- Effective Diagrams in Decision Support — Stanford
- Group Sensemaking — STI
- Shared Information Virtual Surfaces — CSU
- Decision Making Constructs in a Distributed Environment — SPAWAR

Thrust Area: Human-Centric Collaborator-Agent Interfaces

- Dynamic task Allocation — NAWC AD
- Augmented Reality Visualizations for Shared Understanding — SPAWAR
- Human Agent Collaboration Architecture — ISTI
- Hybrid Collaborative Environments

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Representation and Transfer of Meaning

- **Electronic Card Wall**
  Convention-free computational environment for distributed collal

- **Effective Diagrams in Decision Support**
  Use of diagrams/maps to represent language, ability and goal in
  common meaning in complex, collaborative decision making.

- **Group Sensemaking**
  A cognitive model for group sensemaking and for social construc
  consensus and knowledge among interdisciplinary team members

- **Shared Information Virtual Surfaces**
  Shared information surface with distributed players to analyze co
  pattern recognition and situational assessment tasks.

- **Decision Making Constructs in a Distributed Environment**
  Design of user interfaces to improve collective intelligence and sh
  understanding in heterogeneous, distributed decision teams.

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Human-Centric Collaborator-Agent Interfaces

- **Dynamic task Allocation**
  Human-Intelligent Agent collaboration strategies for dynamic task
  time-compressed air warfare target selection.

- **Augmented Reality Visualizations for Shared Understanding**
  Filter, modify and present video scene information for improved sit
  understanding and problem solving within the boundaries of comm

- **Human Agent Collaboration Architecture**
  Understanding and modeling the human role in C2 decision making
  human-centric agent-based decision aids.

- **Hybrid Collaborative Environments**
  Recreating the optimal collaboration venue in distributed decision
  through use of hybrid (physical and digital) support tools.

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Collaboration Models and Computational Methods

- **Modeling Computer-Mediated Joint Activity**
  A software agent that cognitively models the development of conver
  shared meanings, and understandings in a distributed collaborative

- **Coalition Command Center Models**
  Application of reconfigurable organizational design models for
  support of heterogeneous command centers in coalition operations.

- **Generative Decision Support Architectures**
  Develop agent-based models of decision support systems that can u
  software to build decision aids interactively.

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Long term Requirements for

Collaboration and Knowledge Management

- Evolving Military Mission
- Resultant Requirements

Summary

- Challenges / Issues
- Military Impact
- Future Directions

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EVOLVING MILITARY MISSION

- **From Extended Major Engagement with Single Opponent to Local Discreet Events**
- **More Focus on HA / DR Operations Representing One-of-a-Kind Situation**
- **Requirement to Deal with Joint, Coalition, NGO, Volunteer Organization Partners**
- **Dealing with Open-Source (Uncertain, Conflicting, Partial, Non-Official) Data**
- **Rapidly Changing Team Members and Associated**

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REQUIREMENTS SUMMARY

- **Knowledge Interoperability Among Heterogeneous Participants**
- **Cognitive-Friendly Operator Interface with Supporting Agents**
- **Conceptual and Executable Analytical Tools to Support Collaboration**
- **Language Independent, Situation-at-a-Glance Visualization**
- **Cognitive Process-Leveraging Models and Tools for Collaboration**
- **Agent Interfaces that Can React to Human Variation**
- **Flexible Team/Organizational Response to Workload Variation**
- **Models/Computational Methods for Naturalistic Decision Making**

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TECHNICAL CHALLENGES / ISSUES

- **How to Represent and Transfer Meaning**
- **Numerical to Graphic to Symbolic to Conceptual Agility**
- **Build Cognitive Friendly/Cognitive Process Leveraging Interfaces**
- **Modeling Subjective Reasoning/Course of Action Selection**
- **Cultural/Language/Experience-Free Representation of Knowledge**

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Potential Military Impact:

- **Provide Knowledge-Enabled Crisis Management Capability**
- **Provide Joint, Coalition, NGO Decision-Making Interoperability**
- **Enable Improved Battlespace Situational Awareness**
- **Enable Superior Speed of Command and Course of Action Selection**
- **Provide Virtual Command Presence**
- **Collaborative Decision Making for Distributed**

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FUTURE DIRECTIONS

- Crisis/Problem Prediction
- Define Cognitive Performance Metrics
- Reconfigurable Information Fusion
- Decision Making through Synthetic Experience
- Context Sensitive Filters
- Consultive Advisors
- Real-time What-if Analysis

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BACK UP

Topic Discussion Sessions

BREAK OUT SESSIONS

11:15 TO 12:15

TOPIC LEADER SUMMARIES

13:30 TO 14:30

GENERAL DISCUSSION

14:30 TO 15:00

Topic Discussion Sessions

- What are the science issues, gaps, unresolved problems in
- What are the high potential new technologies that may co
- What are some of the current strong contributions in this

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Topic Discussion Sessions

- One hour break-out by topic
- Group discussion on issues
- Sumary findings
- Summary presentation by group leader

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Shared Meaning and Agent Interfaces

Alterman
Warner
Madni
Bankes
Freeman

Collaboration Models and Computational Methods

Porter/Keel
Hicinbothom
Lange
Handley
Seymour

Human-Centric Design of Collaboration Interfaces

Hayne
Kirsh
Brock
Lawless
Fiorello

Representation and Transfer of Meaning

Nosek
Noble
Yufic
Tversky
Hurley

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FOR EACH TOPIC AREA:

- **List five important unresolved research issues, challenges or questions in this topic area.**

- **List five promising technology opportunities (models, concepts, tools, software,etc)**

- **Identify significant underlying science-based theory or emerging concepts for effective collaboration.**

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BACK UP II

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Thrust: Representation and Transfer

Unresolved research issues/challenges:

- How to resolve cultural knowledge processing biases in a group shared environment?
- How to merge neuronal knowledge processing with cognitive models of knowledge processing
- How to effect transfer of uniquely held knowledge in a distributed, heterogeneous, quick response group environment
- How to train agents to understand and react to human decision making variability
- Computational models of Naturalistic decision Making
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Thrust: Representation and Transfer of Meaning

Promising Technologies:

- Web-based Knowledge Elicitation Tools, e.g. simplified Bayesian Belief Nets
- Augmented Visualization
- Development of shared mental models
- -------
- --------
- ------

Thrust: Representation and Transfer of

Underlying science/concepts/tools:

- Transactive memory
- Convention in joint activity
- Cognitive Task Analyses
- Knowledge Elicitation
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Thrust: Representation and Transfer of

Metrics & Measures of Effectiveness:

- Measures of shared understanding and time needed to achieve it.
- Measures of effectiveness of digital decision aids
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Potential Contributing Technologies

- Shared Mental Models
- Group Knowledge Elicitation
- Transactive Memory
- Team Decision Making
- Cognition of Problem Solving
- Group Sensemaking
- Augmented Visualization
- Convention in Joint Activity
- Human-Agent Collaboration
- Dynamic Task Allocation in Teams
- Digital Transfer of Meaning
- Coordinating Representations
- Cognitive Collaboration Architectures
- Hybrid Collaborative Environments